GIS and Sustainability: Project based Introductory GIS Course Curriculum

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Summary

An introductory level GIS course was modified to incorporate a sustainability focused term project. Students in the class learn the basics of GIS through lectures, intense classroom discussions, and structured laboratory exercises. Incorporating a term project requirement is an effective way for students to gain valuable experience in project development, management, completion and presentation. During the fall of 2009**, the students and the instructors worked closely with various sustainability council members, facilities managers, and administrative officials to identify areas of need where GIS can help address campus sustainability initiatives**. At this time, Furman University was going through the process of developing strategies to collect baseline data relating to campus sustainability, to estimate its carbon footprint, and to effectively visualize some of the complex data as necessitated by Furman's sustainability master plan. **Results were used by the Furman Sustainability council in their study of cost and benefits of achieving carbon neutrality**. The **pedagogical challenges** in conducting a course with 16 different term projects include data availability, instructor time, and compromise on course content. Under these circumstances, extra care needs to be taken in every step of the project to make sure data is handled appropriately, and the assumptions and analysis procedures used are sound.

Conceptualizing the project idea

Projects were identified by asking key individuals on campus including the faculty, administrators and facilities personnel what mapping and spatial analysis services they might need.

Furman University's Director of the Shi Center for Sustainability, Director of Facilities, Head of campus safety and security, advisor for the environmental club and others contributed ideas.

Students were asked to think about how GIS would be applied to the problems these individuals were presenting and what kind of spatial analysis could be conducted with the data they would gather.

Individual projects covered these broad categories related to sustainability:

- Water use
- Energy use
- Transportation (pedestrians, bikes and by campus shuttle)

Some projects require GIS skills not covered in class, in which case students are guided to appropriate online material they will need but given little additional guidance.

Acknowledgments

The work of the following students is displayed here: Terry Brockman, Tori Hedden, Andrew Yowler, Marcus Jones, HuongGiang Tran, Chris Berg, Chris Dixon, and Katie Shultz.

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Proposal and Presentation

Once students either individually or as a group of two identify a tentative project, they must develop a proposal and submit it to the instructor for approval and additional comments. Generally they are required to submit the abstract by the end of the first month of classes, which is about 4 – 5 weeks into the semester.

- The proposal (and eventually the final poster) should address:
  - ✧ Statement of the problem or objectives,
  - ✧ State why the problem is important and relevant,
  - ✧ Previous research on the topic (with references cited),
  - ✧ How GIS will be used to address the problem,
  - ✧ Data sets required for the project and potential sources,
  - ✧ GIS analysis methods that will be used (see **Figure 1**),
  - ✧ Detailed timeline for completing project (including their estimated time for collecting, organizing, analyzing, and interpreting the data as well as assembling the poster). See **Figure 2** for an example timeline.
  - ✧ The project outcomes, and deliverables.
- Students focus on the projects for 8-9 weeks, and are expected to carryout most of the project related work outside of class/lab time.
- The end product is a poster (and other electronic media such as videos, kml files, and photographs) that is presented to the entire Furman community. The posters are also posted on the class website permanently (http://gis.furman.edu/ees201/).

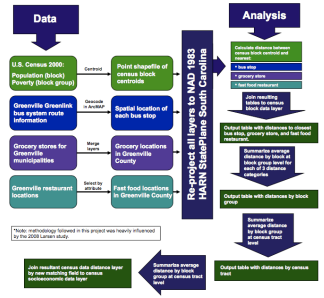


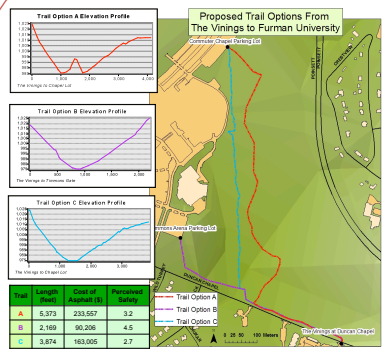
Figure 1. Example of the required flow chart detailing the methods. In this case methods are shown for mapping food deserts in Greenville County, SC

Timeline for project

Week 1	Week 2	Week 3	Week 4	Week 5	Weeek 6	Week 7	Week 8	Week 9
Obtain info and log regarding Shuttle from Public Safety. Input data into GIS format.		If time permits, do case studies on other schools' bus schedule.	If log is unsatisfactory, then employ student survey method. Develop and test survey on a small sample of students. Take online courses for ArcLogistics Route to learn about assignment of locations and stops.	Carry out full scale survey with larger group of students	Input survey data and analyze route data		Incidentals	Create poster

Figure 2. Example of required timeline for student project entitled "The Paladin Shuttle: Potential for Reducing Emissions and Increasing Efficiency in Transportation Service by Proposing a Route Schedule"

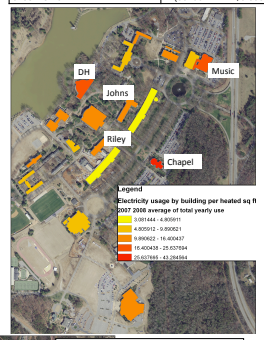
Main Results from a Subset of Projects - Fall 2009



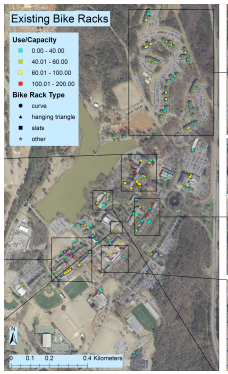
Trail	Length (feet)	Cost of Asphalt ($)	Perceived Safety
A	5,373	233,557	3.2
B	2,169	90,206	4.5
C	3,674	163,005	2.7

PROJECT 1. The map on the left shows the proposed trails from student housing (The Vinings) to Furman University in relation to campus buildings and parking lots. The graphs on the top left show elevation profiles for each trail option. The Table at the bottom left depicts the paving cost and perceived safety as measured by a survey.

Building	Average Yearly Energy Cost
1. Chapel	(762977kwh x $0.053) = $40,438
2. Dining Hall (DH)	(1201972kwh x $0.053) = $63,704
3. Music Building	(991632kwh x $0.053) = $52,556
4. Riley Hall	(630400kwh x $0.053) = $33,411
5. Johns Hall	(657994kwh x $0.053) = $34,874



PROJECT 2: Map of Energy use (in kwh per heated square foot) consumed by main buildings on Furman University displayed as an average of total yearly energy use in 2007 and 2008. Table details the average yearly energy cost of 2007 and 2008 for the 5 least efficient buildings on campus.



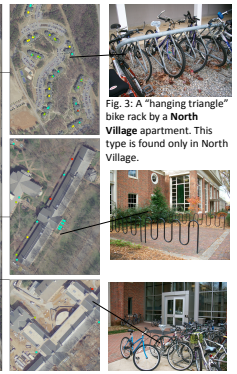
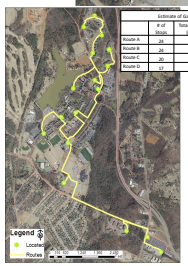


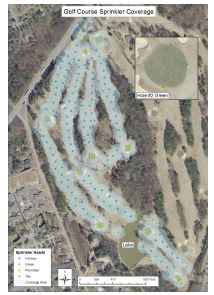
Fig. 3: A "hanging triangle" bike rack by a **North Village** apartment. This type is found only in North Village.

PROJECT 3. Map of the location, type and use/capacity ratio of every bike rack on Furman's campus. Central image is an overview of the entire campus, with surrounding insets highlighting areas of interest and problematic areas.



	# of Stops	Total Distance (miles)	Gas Consumption per Route	Estimate of Daily Gas Consumption
Route A	26	7.14	0.35	1.77
Route B	26	7.67	0.38	1.90
Route C	30	8.93	0.44	1.71
Route D	17	5.45	0.27	1.35

PROJECT 4. One of 4 maps detailing the locations of proposed stops for the campus shuttle. Table above shows the distance travelled and estimated gas consumption for each of the proposed routes. Route D is shown in the map above.



Project 5. Map of sprinkler head locations on the Furman University Golf course.

Pedagogical Challenges

1. **Time commitment**: project based courses, especially real-world applied projects, take a large amount of time to implement both from the student and faculty stand point. A series of meetings with students are necessary especially to narrow down the scope of their project. Follow up meetings to ensure they are on track with their time line, and their methods and models are sound are crucial.

2. **Data needs:** Having a large class size and individual term-project requirement necessitates a variety of data that may or may not be readily available, or that may be too expensive. Providing the students with a strict deadline to identify data sources and data availability in the first week or two of the project period is important. Students may choose to change their project solely based on lack of available data, so requiring students to have a backup project is a good idea to incorporate in the proposal writing stage.

3. **Students underestimate time and effort needed:** tasks that seem simple could take up a large amount of time and at times not produce desired results. Most students are not experienced in doing GIS projects independently, so they are shocked and overwhelmed by the workload, especially towards the end of the term. Keeping them focused, assessing their progress and rewarding them with points that count toward their final project grade are useful ways to keep them motivated.